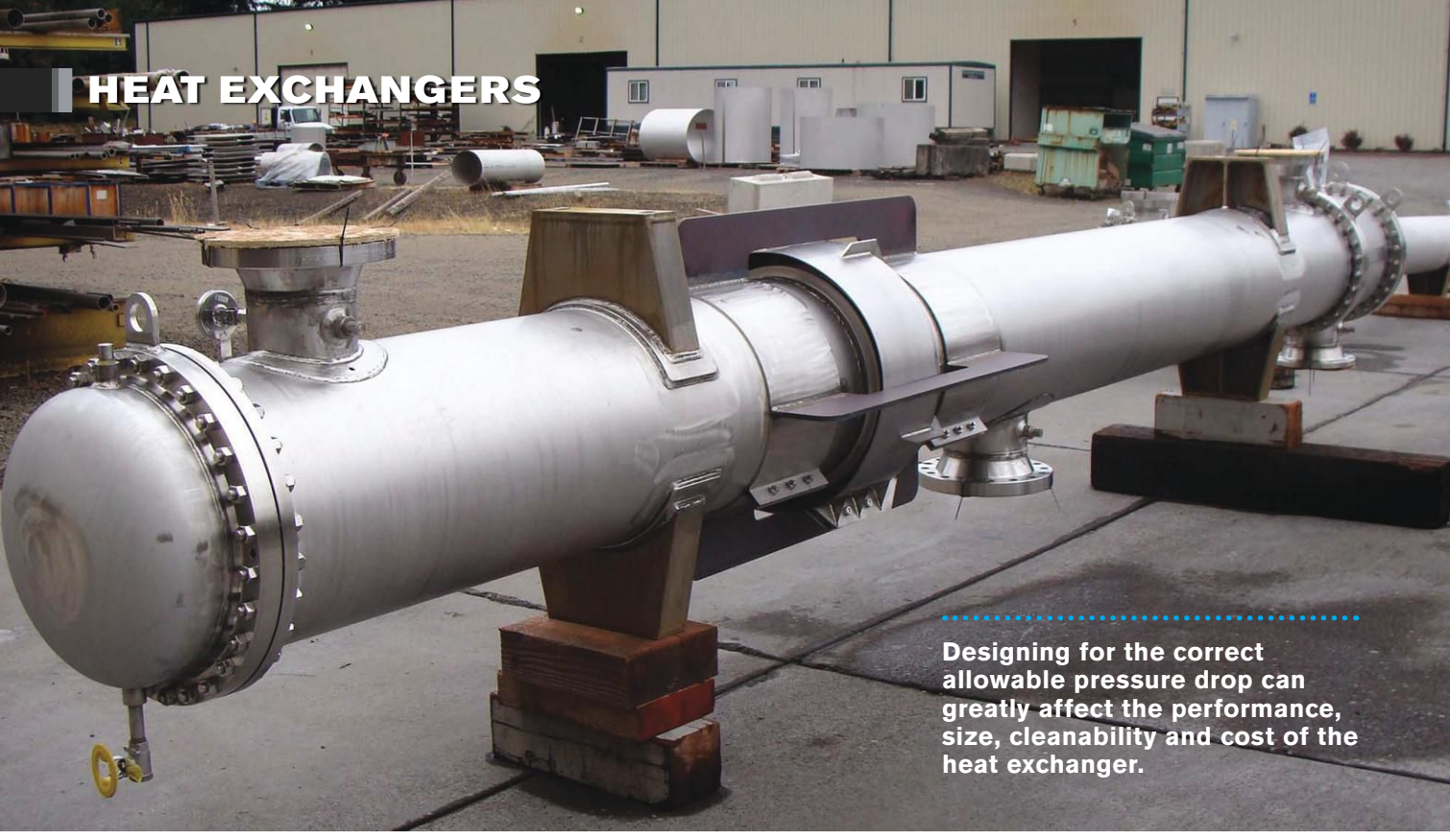

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Heat Exchanger Homework

Consider these five questions when designing process cooling equipment.

By Owen Zentil and Dean Marleau, Marks Brothers Inc.

In process industry operations, the difference between success and failure can be as simple as asking the right questions. When designing process cooling equipment, not doing your homework can lead to unplanned shutdowns, costly maintenance – or worse.

It all starts with finding a fabricator that you can trust. Manufacturers are not created equal. You can build the same heat exchanger in four different shops and get four different end products. From fabrication quality to management to documentation, no two shops are the same. That said, it is important to talk to other customers who are currently working with the fabricator you are considering or who are having similar equipment built. It also is important to ensure that the manufacturer understands the specification document as well as the intent of the spec. Also, the

manufacturer must have successful experience doing the type of work you seek.

Create a short list of qualified fabricators, and visit their shops for a deeper dive. Look into things like their materials segregation practices, which help avoid cross-contamination issues. Ask to review the welding procedures, and make sure they can be adjusted to meet any unique requirements you may have. Check to see that the fabricator has the equipment and know-how to test your equipment thoroughly prior to shipping.

Once you find a reliable fabricator that checks all of these boxes, work with the team to address the following five questions during the planning phase. The extra effort can help keep your project on track and might even extend the life of your equipment once it is installed.

1. Are the Materials of Construction Suitable for the Process and Cooling Medium?

This can be a complicated question that requires research to get to a dependable answer. In fact, there are whole books written on materials selection for processing industry applications.

It is important to discuss your goals with an experienced fabricator prior to designing equipment like heat exchangers. Is the goal to build a unit that will last 20 years and require only annual maintenance during planned

turnarounds? Or, perhaps plant engineering wants to lengthen the lifetime of equipment already operating in severe service?

So that your heat exchanger can be designed to meet your unique requirements, be sure to provide your fabricator with details on your process conditions and how you plan on operating the unit. For example, if you are upgrading tubes in a heat exchanger, how will the new materials affect thermal performance, mechanical integrity and vibration potential? You do not want to try and make the unit better and then inadvertently cause a different issue that may end up being worse.

Cost and availability of materials come into play as well. Material selection becomes an important consideration because of the differences in cost and lead time. For example, Type 304 stainless steel may be low cost, but it lasts for 10 years. By contrast, 6-Moly may be a moderate cost and provide 18 years while Alloy C may be more expensive but provide a 35-year life expectancy.

Working with your fabricator will go a long way toward a successful project. Your fabricator may even suggest corrosion-resistant materials and other options that you have not considered.

2. How Much Pressure Drop Can Your Process and the Cooling Medium Afford?

Designing for the correct allowable pressure drop can greatly affect the performance, size, cleanability and cost of the heat exchanger.

There are several ways that your fabricator can design to increase or decrease pressure drop, velocity and performance. For example, more tubes can be added to reduce tube-side pressure drop, or the tube pitch could be increased to decrease the shell-side pressure drop. Unfortunately, as you tweak one part of

Work with your fabricator to ensure that the best possible welds at the tube-to-tubesheet joints are achieved and the unit lasts as long as possible.

the heat exchanger, it could adversely affect the others. If you do not balance the pressure drop, velocity and performance, you could end up with a heat exchanger that does not operate in accordance with the conditions you were expecting. It could require more maintenance, or it could fail prematurely.

To avoid these scenarios, be sure to let your fabricator know about your pressure drop and any other attributes that could factor into the design of your equipment. This will help them design and fabricate a unit to fit your specific needs.

3. What is the Best Design for the Tube-to-Tubesheet Joints in the Heat Exchanger?

The importance of tube-to-tubesheet joints can be easily overlooked when designing a heat exchanger. Often, people will not call out specifics on the tube-to-tubesheet joint in their bid packages. Getting these details right is vital to building dependable equipment.

The tube-to-tubesheet joint can be the weakest link between the tube-side fluids and shell-side fluids, and it is common for tubes to leak and get plugged over time. Either the tube itself becomes compromised or the tube-to-tubesheet joint is compromised. The reliability of tube-to-tubesheet joints depends on the design, the manufacturing processes (including the people performing the manufacturing) and testing.

Welding, expansion and testing methods, among other factors, can lead to significantly different costs. For example, assume that someone is designing a heat exchanger with 2,000 tubes – a not uncommon number. If the designer specifies a two-pass weld on the tube-to-tubesheet joint (rather than a single-pass weld), in effect, they are specifying 4,000 additional welds.

The design of this frequently forgotten weld joint can impact lead time, cost and, ultimately, reliability of the unit. The time to run 4,000

One of the first things to consider is whether the tube bundle needs to be removable for cleaning. Be sure to specify whether you want to be able to pull out the bundle to clean all areas or if just cleaning accessible areas is acceptable.

additional welds and perform the additional inspection adds up quickly. In addition to costs, such an order requires several days of additional work, which can change the equipment lead time.

When it comes to tube-to-tubesheet joints, ask what your fabricator has done in the past that was successful. Have a clear plan and expectation for the production and testing of the tube-to-tubesheet joint. Bring attention to it, and make sure that it is part of the drawings and quality plan or production traveler. In other words, work with your fabricator to ensure that the best possible weld joint is achieved, and the unit lasts as long as possible.

4. How Are You Planning to Clean and Maintain the Process Cooling Equipment?

Planning for how you will clean your process cooling equipment before it is fabricated will help avoid problems before they occur. One of the first things to consider is whether the tube bundle needs to be removable for cleaning. If it must be removable, you should make clear whether you want to be able to pull the bundle out in order to clean all areas, or if just cleaning the areas reachable from access nozzles is acceptable.

While a removable bundle makes it easier to replace the bundle or some of its components

without having to cut apart the exchanger, considerable internal and external design differences exist between a removable bundle and non-removable bundle. If the bundle need to be removable for cleaning, it must be designed so that it can be separated from the shell. It also must have proper lifting and supporting systems to help avoid damaging the bundle while it is being removed or reinstalled.

Overlooking things like the potential for fouling in the equipment can lead to big problems down the road, including loss of production and blown maintenance budgets.

5. Is There Enough Room to Maneuver During Installation, Maintenance and Removal?

Although the availability of space seems like basic information when planning a process cooling project, there is a lot more to it than meets the eye. Not only does there need to be enough room to install equipment like heat exchangers, but it is also a best practice to plan for maintenance and eventual removal.

For instance, your fabricator could install a fully assembled heat exchanger during an outage. You might operate it for years, but when it comes time to service it, there is not enough room to remove the bundle. Or, after many years of operation and changes in engineering personnel, the new team might lose sight that the older process cooling equipment contains a removable bundle and install new equipment in the area needed for removing the bundle.

Many other considerations also come into play in the successful design, installation and maintenance of process cooling equipment. One seemingly minor detail could be the difference between process cooling equipment that performs as planned and a problematic heat exchanger that requires frequent maintenance or, worse yet, needs to be replaced short of its intended lifecycle. Taking the extra time to do your homework will save you trouble in the long run. **PC**

Owen Zentil is in sales and Dean Marleau is the engineering manager with Marks Brothers Inc. The Boring, Ore.-based company can be reached at 503-663-0211 or visit www.marks-brothers.com.